Towards Better Hole Cleaning

- High lubricity mud and the Use of Sweeps for Hole Cleaning; Understanding the Hole Cleaning Mechanisms

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Many Types of Systems

- But Still 3 Foundations
  - **Water-Based (WBM)**
  - **Oil-Based (Diesel) (OBM)**
  - **Synthetic-Based (SBM)**
    - **Progressively higher costs and applicability as drilling severity increases, whether it's HP, HT, ERD, Hole Stability or, as is most common, a combination of these**

Water-Based Systems

- Benefit the most from lubricants
- Combinations of surfactants, mineral oil, snake oil
- Most successfully used in fit-for-purpose approaches, MLD
  - **Milne Point cocktail, ANS**
- Highest Friction Factors of any system with the lowest $/bbl cost
- Drill-In Systems (Flo-Pro)

Diesel Oil Muds (OBM)

- Expensive, but very tolerant of contaminants and high temps
- Very stable, minor barite swap tendencies, Compressive
- Very good lubricity
- Serious Issues
  - **Exposures**
  - **Discharges**
  - **Disposal, Housekeeping**

Synthetic Based (SBM)

- Most predominant usage in ERD, Deepwater & areas with hole stability problems
- Very expensive, high lubricity
- Two main types, esther & I-o
- EPA discharges & LC50 issues
- Require the use of a BMP & compliance engineer
- Problems with LOC

SBM Characteristics

- Compressible like OBM
- Lose density as temp rises
- Very subject to barite swap
- Need to be very careful to stabilize density in well before drilling after a trip
- Cuttings dryers, oil retention and monitoring with compliance engineer

Hole Cleaning

- Hole Sweeps
- Hole Angles <30º
  - **Improve as well goes vertical**
- Very low benefit >30º
- Mainly contaminate mud system and drive up rheologies, causing other wellbore problems
- Satisfy the Office (or Field)

Hole Cleaning Model

- Lore is full of references to chip velocity, annular velocity, hole cleaning profiles (plug to laminar to turbulent)
- All explained in vertical wellbores with concentric annuli
- Seen any of those around lately?

Real Wellbores Today

- Directional Wells, Eccentric Annuli
- Varying hole angles and turns
- ECD problems lead to controlled ROPs, minimum rheologies
- Cuttings fall to bottom of wellbore around drill string, particularly in angle building sections when there's a high proportion of sliding vs. rotary drilling

Some Snapshots

- 0º – 30º
  - **More traditional hole cleaning**
- 30º – 50º
  - **Cuttings dune, Avalanching**
- 50º – 90º (and beyond)
  - **Cuttings dunes slowly working up the wellbore**
- Picture a sweep in each annulus

How Does Hole get Cleaned?

- The real answer is that many times it doesn't, resulting in stuck pipe, wasted time on trips, lost wells
- Drillers are Optimists
  - **ERD: Exactly Reverse Direction**
- Assume hole is NOT clean until it proves otherwise
- Torque, Drag, Circ Press, Cuttings

String Rotation

- This is the real key to hole cleaning
- Not just any rotation: low rpm is insufficient
- ERD Specialists have noted step changes at 120 rpm and again and 150-180 rpm, depending on drill string size
- Not a panacea if ECD is a problem

Patience

- Holes with extended 70º and above tangent sections rarely even begin to clean up until 2 bottoms up are observed
- Dunes are moving up the well and the hole will unload suddenly
- 4 bottoms up is typical, it can be more
- Torque/Drag analysis: condition

Drilling while Cleaning

- It's not impossible, but the mechanisms need to be understood as they apply to a given wellbore geometry
- Great advantage of rotary drilling vs. motor drilling is hole cleaning (plus the lower tortuosity and micro-doglegs from tool sets)
- Weighing cuttings

Summary Points

- Mud systems fit for purpose
- Understand Hole Cleaning mechanism through a given well
- Dubious value (& wasted money and time) of sweep combinations
- Designing the well to be cleaned
  - **Drilling Clean (Motor Housings)**
  - **Tripping Clean (Hole Cleaning)**
  - **Casing Clean (Back Reaming)**